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Geotechnologies for Global Development

Submitted by the Spanish Society of Cartography, Photogrammetry and Remote Sensing**

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GEOTECHNOLOGIES FOR GLOBAL DEVELOPMENT

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1.-Information Society and Geotechnologies.

During the last decade there has been a highly growing transformation and technological change process, which has led to substitute the "industrial society" notion for the one related to the "information society". It is widely asserted that we are living in a new age in which the information technologies play a very relevant role as the driving force of the deep changes to be carried out within the social behaviors, the economic activity and the employment.

Until the 90's, new technologies, since then known as information technologies, were commonly used on the task and production process automation, without leading to a significant change within the economic and social patterns. However, during the most recent years three new incidents cause a deep social transformation, and actually direct us into the "information society". First of all, **multimedia** products are introduced and widely spread amongst consumers, which removes the bounders between the different levels of communication. Secondly there are **mobile** terminals, which help us to communicate in several ways anywhere on the Earth, outside our dwellings or places of work. Lastly, the **Internet** arises amongst users and becomes the most innovative tool for knowledge and information exchange ever known.

These technological changes, which I pointed out briefly , have a deep and positive effect within the geotechnology field. The remote sensing, the

global navigation and positioning satellite systems, the geographical information systems and, in a broad sense, the information technologies have contributed to a change in the work and research methods in geoinformation. At the same time, this change is also appreciable in specific areas such as industries, official bodies, research and educational institutions directly related to this science.

The technological development in these fields will dramatically grow in the following years. The new generation of satellite constellations for the Earth observation and the navigation will enhance the current performance regarding accuracy, availability and data quality. On the other hand, a joint use and management of the advantages offered by the remote sensing and the Global Navigation and Positioning Satellite Systems will place them in the avant-garde of the creation of land information. The description and transformation of the Earth geography through digital patterns, based on high-resolution graphics, with a huge data volume, will be very helpful as a referentiation support to databases managed by Geoinformation Systems. These databases will be extremely important for a sustainable development.

2.- Geotechnologies for territorial knowledge

In the 20th century significant improvements have been achieved regarding the development and exploitation of science and technology to meet human requirements. At the beginning of the new millenium, the world community faces many challenges concerning its sustainable development and the reliable environment management, as well as remarkable chances for the scientific and socioeconomic development. The advantages of the information society must reach the whole world population without any exception. Thus, it will give rise to the knowledge society. It is extremely

important to consider that globalization will only be successful if it can benefit the whole world population.

We face the increasing threats of natural disasters and rapid environmental changes, including climate warming and its effects, deforestation, desertification, and land degradation, ozone-depletion acid rain and a reduction in biodiversity. Such changes have an influence on people quality of life, as well as on the essential requirements to guarantee the human being survival anywhere on Earth.

Geotechnologies must help to solve these problems, about which there are still extremely important scientific controversies to reach a sustainable development. These challenges, dramatically showed on these matters, will set the criteria for development and will constitute a vital task for new technologies before the new millenium. Undoubtedly, geoinformation has become the touchstone to analyze all the events taking place on the surface of Earth and the changes produced on it by the effects of time. For these purposes, remote sensing techniques and continuous georeferentiated data retrieval will increasingly become essential and necessary tools.

The appropriate exploitation of the information retrieved through Earth observation from artificial satellites (orientated towards its natural resources, agriculture, huge forest areas, mining resorts and environment) will allow the public management heads to make satisfactory decisions, based on the actual state of every sector. Therefore, it will allow them to adopt policies leading to diminish the indefinite and negative effects over environment preservation and protection.

3.- Earth observation from outer space.

Nowadays, Earth observation satellites constitute an important and outstanding source of information related to inquiries based on the Earth system. Today, 45 Earth observation satellites have been launched. They provide relevant data to the different research fields dealing with space technology. In the next 15 years, 70 new missions will be carried out to launch 230 analysis and Earth surveillance appliances.

The data retrieval with passive systems -that is to say, those that register the solar radiation reflected on land- began in the seventies when the North-American satellite TIROS-1 was launched. In 1972, after the launch of the satellite Landsat 1, it was achieved an 80 meter resolution. In 1982 the Thematic Mapper sensor joined the Landsat 4, and 29-meter resolutions were achieved. Later, in 1986, the French satellite Spot was launched and, subsequently, a 10-meter panchromatic resolution was obtained. Since 1988, the Indian satellite IRS provides a 6-meter resolution.

On the other hand, it is convenient to expound the development of radar systems, categorized as active due to their radiation transmission and subsequent measurement of the response reflected on land. These radar systems were successfully applied from year 1995, after the launch of the Canadian satellite Radarsat, which featured a 25-meter resolution in both terrestrial and oceanic coats, under any weather condition, day and night. A very interesting feature for areas that remain overcast for almost the whole year.

In next three years a new high-resolution satellite generation will become an innovative data source, mainly aimed at business projects. The satellites' resolution will be from 0,8 to 5 meters on the panchromatic band and from

3,3 to 20 meters on other multispectral bands. Conversely, the new Radarsat's resolution will be 3 meter.

Thanks to the information provided by these satellites and its high resolution capability, many data will be obtained from: the Earth coat, the delimitation of the different units involving the landscape, the accurate interpretation of its nature and contents, as well as the geographical coordinates indicating its geographical position. This is a very valuable information, since it can be used as a powerful device to research into agricultural and forest matters, natural resources and environment status. On the other hand, since it can referentiate that large amount of information on chart databases, by using three-dimensional patterns, it constitutes a very reliable tool as a document or a working bench for studies and researches related to Geography.

On the geotechnology field it is easy to identify, with high accuracy, ten different types of basic data that will allow to be jointly exploited in order to approach the problems arising from the sustainable development and the environment preservation within a global scope. These types define the topography, the land use, the air quality, the subterranean and superficial water quality, the climatology, the demography, the hydrology, the infrastructures, and the economic and geological production.

4.- Global Positioning Systems

The experience attained during the last twenty years on the usage of the U.S.A. Global Positioning Systems –GPS- shows a high level of performance on geodesy, cartography, topography, and within the fields of transport, vehicle and individual localization, agriculture, oceanography, meteorology, geology and research and people rescue operations.

Therefore, GPS has become the best system to provide geographical data, coordinates of any point on Earth and the subsequent and accurate identification of the land features.

Regarding its current and future applications, it is necessary to consider the evolution of positioning systems towards Global Navigation Satellite Systems, which nowadays are internationally known as GNSS. The European Union, by means of the Council's Resolution -December 1994- on the contribution to the development of a global navigation satellite system, started a European policy that leaded in 1998 to the adoption of a Communication of the Transport Council on GNSS Strategy. In 1994, two consecutive phases were defined: the first one known as GNSS-1 or EGNOS, which enhanced or increased the performance of the existing constellations and the second one, known as GNSS-2 or Galileo, which created a new European satellite constellation.

The first phase is called EGNOS. The system architecture was designed in order to complement or increase the performance of the American GPS System and of the Russian GLONASS, so that the signal ensured its integrity, accuracy, availability and continuity, necessary for the different means of transport.

It is developed together with similar initiatives in the USA and Japan. Thus, three big areas of the world will be covered by similar augmentation systems: the American WAAS, which will fully operate in 2002; the Japanese MSAS and the European EGNOS, which will operate in 2003.

It can be confirmed without any doubt that, during 1999, the European Union developed a very important activity to promote, as a political

priority, the Galileo project. In February, the Commission's Communication on Galileo -"The participation of Europe in a new generation of satellite navigation services"- was approved and, therefore, the essential criteria and guidelines that must inspire Galileo were set down. In June, the Transport Council approved the Resolution that started the Galileo definition phase, which must be carried out together with the European Space Agency. In December 2000, the European Union finally approved the launching of the Galileo project.

The Resolution approving the definition phase of Galileo establishes an ambitious goal regarding the system exploitation, the implementation of a multimode infrastructure for the different means of transport -air, land and maritime- as a support of an integrated transport system. The above mentioned goal intends to enhance the safety and to reduce the problems taking place nowadays, especially, the flow of traffic, thus leading to a decrease of air pollution generated under the current congestion conditions, by means of the usage of alternative routes arising from the continuous knowledge of the situation.

Should not the European Union take this initiative, our industrial sector would become deeply weak and could not participate in the associated technological development nor compete within the world-wide market of about four thousand million dollars in 2005. GALILEO will make Europe have the duly market share and the relevant creation of employment. This will provide the space sector enterprises with the capacity to deal with advanced projects in future applications and, to participate actively in the definition and implementation of space and land systems of the new satellite constellation.

The remarkable technological evolution that will take place in the satellite navigation sector has an essential meaning in its aspect of a new homogeneous infrastructure of global information, which constitutes a reference point as a geographical information global infrastructure. This evolution also involves a new performance in the geographical positioning accuracy and in the air, land and sea navigation, along with complementary applications such as the universal implementation of time exact access system.

5.-Geographical Information Systems.

This is the scope where the collection of land information in the first decade of 2000 is focused on. Specific projects in the remote sensing and satellite navigation fields will determine the essential benchmark for the geographical knowledge. Thus, it will be possible to collect huge volumes of digital data regarding the events occurring in the Earth surface. This also involves a clear challenge that will be expressed in the capacity of turning this data into useful information for the different users.

The USA Vice-President's speech on The Digital Earth expressed this worrying by referring to the Landsat programme. This programme allowed us to take complete images of the Earth every two weeks during the last 20 years, though most of these images have never been used and remained stored in electronic silos with no other usage.

This situation can only be overcome by means of a general use of the geographical information systems. This will be transformed into the storage support and georeferentiated data management systems. Moreover, it will be also transformed into the presentation instrument of information in the required form for the different users of the multiple sectors in which the

human activity has, as a unique and main reference, the territory where they live together.

The geographical information systems are defined as the essential instruments for the organisation, treatment and integration of data by means of the appropriate algorithms and the product generation in the most suitable format and presentation for every work area. Their future is linked to that one of the information technologies; the dramatic advance in these technologies will also enhance important changes and bigger potentialities in the SIG.

On this matter, the geographical information systems consist of vital instruments for the integration of data obtained by different sources, thanks to the application of the appropriate algorithms that produce exits and a more suitable performance to the specific necessities of the target users.

An important value in the future regarding the usage of the SIG is the capacity it has to deal with different data, contents and formats and allows a wide flexibility when treating them. This usage also permits to integrate the data above and to show them with possible alternatives adjusted to the established requirements. On the other hand, a progressive growing of added value products will take place where their contents will provide very high levels of information compared to those levels of the starting databases.

6.- Public Policies for the management of basic land data.

In their global perspective, the information infrastructures have turned into a vital element for the development of countries. On a international level, the concept of global infrastructure of information is being discussed on the

basis of the real possibility of open connection and public access to the information. That different national government and international organisations are becoming aware of the conceptual change that is occurring with the general implementation of the information society, since the public administrations, from their national and global point of view, are the main sources of information.

The Public Administration produces information in order to develop its own competence, that is, the information needed for the political management and economic planning. These data cover every area of activity, socio-economic statistical and industry data and also, demographic, geographical, geological, hydrographic, Land Registry, estate property data, which allow to know the reality of the different territories. Nowadays, this information is also necessary for the entrepreneurial management that must be based on the territorial knowledge and on its basic georeferentiated data, as supporting elements for the enterprise decisions.

According to the European Commission, 80% of the current available databases can be geographically referred to. On the other hand, the number of digital geographical databases is growing exponentially in the developed countries and adopting new forms of expression in which both vectorial and raster data are complementary by means of video and audio information. The applied technology advancement allows to obtain dynamic multimedia representations, which along with the usage of maps, images and digital models, shows the changes occurred in geography during the years and overcomes the fixed and traditional graphic view.

Nowadays different long and short-term prospective exercises take place in order to situate the geographical information systems in their coming future. For that purpose, it is convenient to deepen those aspects related to their administrative support and work guidelines that must be established and to their integration in the national institutions responsible for the production and treatment of the basic land data. The training of experts in this field will constitute an indispensable condition so that these institutions could carry out their own responsibilities. Thus, they will independently value which are the most appropriate technological resources to create their own basic infrastructures of geographical information, without rejecting their wished capacity and decision independence.

Regarding this subject, the most urgent task is the definition of public policies that contribute to develop the usage of geotechnologies. They must help to solve the problems emerging from the different sectors of society, by means of an approach that envisages the more and more necessary collaboration of the public and private entrepreneurial sector. It is also necessary to facilitate the conditions in which any citizen or organisation can access the data and produced by the public sector from institutions specialising in geoinformation.

7. Geotechnologies in the XXI Century.

During this century, the exploration of the earth surface has been completed. There are neither territories nor continents to be discovered, since man knows the most isolated places, mountaintops, rivers, plateaux, glaciers and deserts and has already mapped them and revealed their form and dimensions. It might seemed that it is the end of the great geographical adventure of the mankind, but it is now when modern space technologies provide us with new and advanced instruments in order to continue the task

that goes to the geographical science. A new phase, in which it is not enough to know the most important traits of the earth surface, is opened. It is advisable to define it digitally and to reveal the multiple and difficult inter-relationships existing amongst the human beings and the environment they live in.

The information was firstly obtained by measuring every plot of land with simple topographic instruments and, afterwards, thanks to air pictures, different topographic models become available. It was not necessary anymore to cover every meter of the territory in a process where the point of view for the taking of data moved away from the own plot of land. First it was used a compass situated in the earth and then a camera in an aircraft. Nowadays, the sensors used for this purpose are situated in the space, in satellites, very remote from the plot of land, and, at the same time, they are able to offer a metric vision of the places we live in.

In the complex society of the future, geotechnologies, supported by new equipment generations and systems that will allow us to continue the knowledge adventure, will hold a vital role. The geotechnologies contribution will be indispensable in order to improve population's quality of life, the environment conservation and the preservation of the balance between man and his/her environment, the preservation of which constitutes a must for the existence of life.